

## CLAIMS

1. A method for controlling a synchronous permanent magnet multiple-phase motor, comprising the steps of:
- 5       - determining a frequency optimized in function of the characteristics of the motor, said optimized frequency being able to be made constant or variable depending on the status of the motor,
  - controlling the drive current supplied to each motor phase by turning it off in whole or in part at said optimized frequency,
  - 10       - virtually simultaneously measuring the induced voltages of at least two motor phases, when the power in said motor phase is turned off, with a sufficiently high sensitivity to be able to determine a rotational speed of the motor at near-zero speed,
  - sampling the measured induced voltages at said optimized frequency,
  - 15       - determining the rotor position and/or the rotor speed from signals resulting from said samples,
  - entering said determined rotor position and/or said determined rotor speed into a state filter which delivers a filtered rotor position and/or a filtered rotor speed,
  - 20       - adjusting the drive current as a function of said filtered rotor position and/or filtered rotor speed.
2. The method according to claim 1, wherein the state filter is arranged so as to take into account the physical knowledge that when the speed of the motor is very low, the position of the rotor can not change substantially over a short period of time.
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3. The method according to claim 2, wherein said state filter is a Kalman filter.
- 5 4. The method according to any of claims 1 to 3, wherein the measured position  $\theta$  of the rotor is determined by the formula , where  $U_a$  is equal to the measured induced voltage in one phase and  $U_b$  is equal to  $\frac{V_2 - V_3}{\sqrt{3}}$ ,  $V_2$  and  $V_3$  being the measured induced voltages in the other two phases.
- 10 5. The method according to any of claims 1 to 4, wherein the measured speed of the rotor is determined by computing the square root of the sum of squares of measured induced voltages.
- 15 6. The method according to any of claims 2 to 5, wherein the said state filter implements an algorithm such as
- $$X = X_{-1} + (a * V * T + b * dP) \div 2 ,$$
- where  $X$  is the estimated position at time  $t$ ,  
 $X_{-1}$  is the estimated position at time  $t_1$ ,  
 20  $X_m$  is the measured position using back EMF voltages at time  $t_m$  with  $(t_1 \leq t_m \leq t)$ ,  
 $V$  is the measured speed using back EMF voltages at time  $t_m$ ,  
 $T$  is the time duration between 2 successive measurements ( $t_1$  and  $t$ ),  
 $dP$  is the difference between  $X_m$  and  $X_{-1}$ , such difference being  
 25 however limited to  $\pm(c * VT + d)$  and  $a$ ,  $b$ ,  $c$  and  $d$  are coefficients which depend on the motor characteristics.

7. An electronic device for controlling a synchronous permanent magnet motor (1) with at least one phase, a coil, a rotor and a motor driver (2), comprising
- 5       detection means (3), which are connected to the phases (A, B, C) of the motor and deliver signals that represent induced voltages of motor phases, said detection means having a high enough gain to provide significant output signals even if the speed of the rotor is near-zero, and
- 10       a control circuit (4) connected to said detection means and to the motor driver (2), which supplies driving currents to the motor, said control circuit comprising means for computing the position and/or the speed of the rotor from the output signals provided by said detection means.
- 15   8. The electronic device according to claim 7, wherein said detection means comprise, for each phase of the motor, a differential amplifier (31, 32, 33) the inputs of which are connected to two different phases of the motor and an analog-to-digital converter (34, 35, 36) to convert the analog signal outputted by said differential amplifier into a digital signal,
- 20       which is applied to said control circuit.
9. The electronic device according to claim 7 or claim 8, wherein the control circuit further comprises a state filter for filtering signals representing the position and/or the speed of the motor determined from the output
- 25       signals of said detection means.

10. The electronic device according to claim 9 wherein said state filter is a Kalman filter.